

CLAIMS

What is claimed is:

1. A process to remove phosphorus from an aqueous stream, which comprises phosphorus, comprising: (a) adjusting pH of the stream to a pH of at least 7 by adding a calcium-containing compound; (b) adding one or more metal ions selected from the group consisting of zinc and manganese ions to the stream; (c) adding an anionic inorganic colloid to the stream; and (d) adding a flocculant to produce a flocculated mass.
2. The process of claim 1 wherein the aqueous stream is derived from food processing and the process further comprises recovering the flocculated mass and using the recovered flocculated mass as a nutrient source.
3. The process of claim 1 or 2 wherein the pH of the stream is adjusted to at least 10.
4. The process of claim 3 further comprising lowering the pH to 7 to 9.
5. A process to remove phosphorus from an aqueous streams, which comprises phosphorus, comprising (a) adjusting pH of the stream to a pH of at least 7 by adding a calcium containing compound; (b) adding one or more metal ions selected from the group consisting of zinc ions and manganese ions to the stream; (c) adding at least one cationic organic polymer to the stream; and (d) adding at least one anionic organic polymer to the stream to produce a flocculated mass.
6. The process of claim 5 wherein the aqueous stream is derived from food processing and the process further comprises recovering the flocculated mass and using the recovered flocculated mass as a nutrient source.
7. The process of claim 5 or 6 wherein the cationic polymer is cationic polyacrylamide and wherein the anionic polymer is anionic polyacrylamide.
8. The process of claim 5 or 6 wherein the pH of the stream is adjusted to at least 10.

9. The process of claim 7 wherein the pH of the stream is adjusted to at least 10.

10. The process of claim 5 or 6 further comprising lowering the pH to 7 to 9.

5 11. The process of claim 7 further comprising adding to the stream an anionic inorganic colloid.

12. The process of claim 8 further comprising adding to the stream an anionic inorganic colloid.

10 13. The process of claim 9 further comprising adding to the stream an anionic inorganic colloid.

14. The process of claim 10 further comprising adding to the stream an anionic inorganic colloid.

15 15. A process to remove phosphorus from an aqueous stream, which comprises phosphorus, comprising (a) adding one or more metal ions selected from the group consisting of titanium and zirconium to the stream; and (b) adding a flocculant to the stream to produce a flocculated mass.

16. The process of claim 15 further comprising adjusting the pH of the stream to 7 or lower.

20 17. The process of claim 15 wherein the aqueous stream is derived from food processing further comprising recovering the flocculated mass and using the recovered flocculated mass as a nutrient source.

18. The process of claim 16 further comprising recovering the flocculated mass and using the recovered flocculated mass as a nutrient source.

19. The process of claim 16 wherein said pH is 3 to 5.

25 20. The process of claim 17 wherein said pH is 3 to 5.

21. The process of claim 18 wherein said pH is 3 to 5.

22. The process of claim 19, 20, or 21 further comprising adding to the stream an anionic inorganic colloid.

23. The process of claim 1 or 15 wherein the flocculant is an anionic organic polymer.

24. The process according to claims 1 or 15 further comprising separating the flocculated mass from the stream.

5 25. A process consisting essentially of adjusting the pH of an aqueous stream, which comprises phosphorus, to at least 7 by adding a calcium-containing compound; adding one or more metal ions selected from the group consisting of zinc ions, manganese ions, and mixtures thereof to the stream; and

(a) adding an anionic inorganic colloid and a flocculant to produce a
10 flocculated mass; or
(b) adding at least one cationic organic polymer and at least one anionic organic polymer to the stream to produce a flocculated mass; or
(c) adding a flocculant to the stream to produce a flocculated mass;
recovering the flocculated mass; and using the recovered the flocculated mass as a
15 nutrient source.

26. The process of claim 25 consisting essentially of adjusting the pH of an aqueous stream, which comprises phosphorus, to at least 7 by adding a calcium-containing compound; adding one or more metal ions selected from the group consisting of zinc ions, manganese ions, and mixtures thereof to the stream;
20 and adding an anionic inorganic colloid to the stream; and adding a flocculant to produce a flocculated mass.

27. The process of claim 25 consisting essentially adjusting the pH of an aqueous stream, which comprises phosphorus, to at least 7 by adding a calcium-containing compound; adding one or more metal ions selected from the
25 group consisting of zinc ions, manganese ions, and mixtures thereof to the stream; adding at least one cationic organic polymer to the stream; and adding at least one anionic organic polymer to the stream to produce a flocculated mass.

28. The process of claim 25 consisting essentially of adjusting the pH of an aqueous stream, which comprises phosphorus, to at least 7 by adding a
30 calcium-containing compound; adding one or more metal ions selected from the group consisting of zinc ions, manganese ions, and mixtures thereof to the stream;

adding a flocculant to the stream to produce a flocculated mass; recovering the flocculated mass; and using the recovered the flocculated mass as a nutrient source or animal feed.

29. The claim of 25, 26, 27, or 28 wherein the pH of the stream is
5 adjusted to at least pH 10.

30. The claim of 25, 26, 27, or 28 wherein the pH of the stream is adjusted to at least 10 and is subsequently lowered to 7 to 9.

31. The process of claim 27 consisting essentially of adjusting the pH of an aqueous stream, which comprises phosphorus, to at least 7 by adding a
10 calcium-containing compound; adding one or more metal ions selected from the group consisting of zinc ions, manganese ions, and mixtures thereof to the stream; adding at least one cationic organic polymer to the stream; adding an anionic inorganic colloid to the stream; and adding at least one anionic organic polymer to the stream to produce a flocculated mass.

32. The process according to claim 28 consisting essentially of
15 adjusting the pH of an aqueous stream, which comprises phosphorus, to at least 7 by adding a calcium-containing compound; adding one or more metal ions selected from the group consisting of zinc ions, manganese ions, and mixtures thereof to the stream; adding an anionic inorganic colloid to the stream; adding a
20 flocculant to the stream to produce a flocculated mass; recovering the flocculated mass; and using the recovered the flocculated mass as a nutrient source or animal feed.

33. The process of claim 27 wherein the cationic polymer is cationic polyacrylamide and wherein the anionic polymer is anionic polyacrylamide.

34. A process to remove phosphorus from an aqueous stream, which
25 comprises phosphorus, consisting essentially of adding one or more metal ions selected from the group consisting of titanium and zirconium, and a flocculant to the stream to the stream to produce a flocculated mass.

35. The process of claim 34 consisting essentially of adjusting the pH
30 of the stream to 7 or lower, and adding one or more metal ions selected from the

group consisting of titanium and zirconium and a flocculant to the stream to the stream to produce a flocculated mass; or adjusting the pH of the stream to 7 or lower, adding one or more metal ions selected from the group consisting of titanium and zirconium ions, a flocculant to produce a flocculated mass,

- 5 recovering the flocculated mass, and using the recovered flocculated mass as a nutrient source.

36. The process of claim 35 consisting essentially of adjusting the pH of the stream to 7 or lower; and adding one or more metal ions selected from the group consisting of titanium and zirconium, and a flocculant to the stream to the stream to produce a flocculated mass.

37. The process of claim 35 consisting essentially of adjusting the pH of the stream to 7 or lower; and adding one or more metal ions selected from the group consisting of titanium and zirconium, and a flocculant to produce a flocculated mass; recovering the flocculated mass; and using the recovered
15 flocculated mass as a nutrient source wherein the aqueous stream is derived from food processing and the process.

38. The process of claim 35 consisting essentially of adjusting the pH of the stream to 7 or lower; and adding one or more metal ions selected from the group consisting of titanium and zirconium, an anionic inorganic colloid, and a
20 flocculant to the stream to the stream to produce a flocculated mass.

39. The process of claim 34 consisting essentially of adjusting the pH of the stream to 7 or lower; adding one or more metal ions selected from the group consisting of titanium ions and zirconium ions, an anionic inorganic colloid, and a flocculant to produce a flocculated mass; recovering the flocculated mass; and
25 using the recovered flocculated mass as a nutrient source wherein the aqueous stream is derived from food processing.

40. The process of 36, 37, 38, or 39 wherein the pH is adjusted to 3-5, inclusive.